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Redescription of two cestodes (Eucestoda: Proteocephalidea) parasitic in *Phractocephalus hemioliopterus* (Siluriformes) from the Amazon and erection of *Scholzia* gen. n.

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Redescription of two cestodes (Eucestoda: Proteocephalidea), parasitic in *Phractocephalus hemioliopterus* (Siluriformes) from the Amazon and erection of *Scholzia* gen. n. - *Scholzia emarginata* (Diesing, 1850) comb. nov. [synonyms: *Tetrabothrium emarginatum* Diesing, 1850; *Nomimoscolex emarginatus* (Diesing, 1850) Rego *et al.,* 1999; *Myzophorus pirarara* Woodland, 1935; *Nomimoscolex pirarara* (Woodland, 1935); *Proteocephalus pirarara* (Woodland, 1935) de Chambrier & Vaucher, 1997) is redescribed on the basis of the type series of *M. pirarara* and newly-collected material from the siluriform fish *Phractocephalus hemioliopterus* in the Amazon River, Brazil. The new monotypic genus *Scholzia* gen. n. differs from the remaining genera of the subfamily Proteocephalidae by (1) the morphology of the scolex, (2) strobilar features such as the presence of four posterior lobes forming a velum, (3) the ovary and the vitellaria medullary with cortical projections into the velum, and (4) the vitelline follicles posteriorly converging medially at the ovarian level.
Proteocephalus hemioliopteri de Chambrier & Vaucher, 1997 [synonyms: *Myzophorus woodlandi* Rego, 1984; *Nomimoscolex woodlandi* (Rego, 1984) Rego & Pavanelli, 1992]) is redescribed on the basis of the type series of *M. woodlandi* and newly-collected material from the same host and locality. The morphology and distribution of microtriches of some areas of the body surface of both species are studied and compared. Three types of microtriches were observed in *S. emarginata* and 2 types of microtriches in *P. hemioliopteri*. The distribution of microtriches analysed was not useful to discriminate genera but it may be useful as a supplementary character to distinguish species.

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Keywords: Eucestoda - Proteocephalidea - *Scholzia* gen. n. - *Tetrabothrium emarginatum* - *Myzophorus pirarara* - *Myzophorus woodlandi* - *Proteocephalus hemiliopteri* - *Phractocephalus hemioliopterus* - Amazon - microtriches.

INTRODUCTION

Diesing (1850) described *Tetrabothrium emarginatum* from the pimelodid catfish *Phractocephalus hemioliopterus* (Bloch & Schneider, 1801) and illustrated the scolex and the velum of proglottides characteristic of this species (Diesing, 1856). Braun (1894-1900) also figured this species. Woodland (1935) described the same species under the name *Myzophorus pirarara*. Rego (1984) redescribed this species on the basis of the original Woodland's material; he found, in the latter type species, specimens of another species and described them as *Myzophorus woodlandi*. Rego & Pavanelli (1992) abolished the genus *Myzophorus* Woodland, 1934 and transferred *Myzophorus pirarara* and *M. woodlandi* to *Nomimoscolex* Woodland, 1934. De Chambrier & Vaucher (1997) transferred both species from *Nomimoscolex* to *Proteocephalus* Weinland, 1858, i.e. as *P. pirarara* and *P. hemioliopteri*; the latter name was proposed as a replacement name due to the homonymy with *Proteocephalus woodlandi* Moghe, 1926. Rego *et al.* (1999) did not recognise *P. hemioliopteri* and redescribed it as *Nomimoscolex woodlandi* (Rego, 1984) Rego & Pavanelli, 1992.

Furthermore, Rego *et al.* (1999) recognised *Tetrabothrium emarginatum* Diesing, 1850 as a synonym of *Nomimoscolex pirarara* (Woodland, 1935). However, as the description of *T. emarginatum* is earlier, this name has priority and consequently *N. pirarara* is a junior synonym of *T. emarginatum*.

Recently collected material from the Amazon River, in excellent condition, enables us to redescribe herein both *Tetrabothrium emarginatum* (= *Myzophorus pirarara*) and *Proteocephalus hemioliopteri* (= *Myzophorus woodlandi*), to clarify their taxonomic status and to describe additional characters. In the present contribution, *Tetrabothrium emarginatum* was found to exhibit distinct characteristics justifying a new monotypic genus to accommodate this species.

MATERIAL AND METHODS

The worms were fixed immediately after dissection of fish with hot 4% neutral formaldehyde solution, stained with Mayer's hydrochloric carmine, dehydrated in an ethanol series, cleared with eugenol (clove oil) and mounted in Canada balsam. Pieces of the strobila were embedded in paraffin wax, cross-sectioned (thickness 12-15 μm), stained with Weigert's hematoxylin and counterstained with 1% eosin B (Scholz & Hanzelová, 1998; de Chambrier, 2001). Eggs were studied in distilled water. Drawings were made with a camera lucida.

Two specimens of *Tetrabothrium emarginatum* and 2 specimens of *Proteocephalus hemioliopteri* were prepared for SEM as follows: specimens for scanning electron microscopy (SEM) were dehydrated in graded ethanol series, then transferred in graded amyl/acetate series, critical point dried in CO_2, sputtered with gold and examined by Zeiss DSM 940 A electron microscope. Scanning electron micrographs were made at the Museum of Natural History, Geneva. Microtriches terminology follows Hoberg *et al.* (1995). Measurements of the microtriches were determined from photomicrographs. Microtriches density values (D) were obtained from randomly selected areas of 1 μm^2.

Abbreviations used in descriptions are as follows: x, mean; n, number of measurements; TM, type material; CV, coefficient of variation; OV, ovary width versus proglottis width ratio (in %); PP, position of genital pore (cirrus pore) as % of proglottis length; PC, cirrus-sac length versus proglottis width ratio (in %), BLS = blade-like spiniform microtriches. BMNH, The Natural History Museum, London; MHNG, Geneva Natural History Museum; INVE, Geneva Natural History Museum, Invertebrate Collection. All measurements are given in micrometers unless otherwise stated.

RESULTS

Scholzia gen. n.

Diagnosis: Proteocephalidea, Proteocephalidae, Proteocephalinae. Medium-sized tapeworms, proglottides craspedote with four lobed velum. Unarmed tetralobate scolex, wider than neck, with four oval cup-shaped suckers, directed anteriorly. Apical region very wrinkled. Testes medullary, in one field, in two or three layers. Uterus medullary, of type 1 of development (see de Chambrier *et al.*, 2004b), uterine apertures precociously formed. Ovary medullary, follicular, with cortical projections into velum. Vitellaria medullary with some follicles paramuscular, posteriorly inside vellum, with tendency of posterior concentration. Genital pore anterior, irregularly alternating. Cirrus sac elongated. Eggs laid unripe. Parasites of Neotropical pimelodid catfishes.

Type species: *Tetrabothrium emarginatum* Diesing, 1850. Monotypic.

Etymology: This genus is named after Professor Tomáš Scholz (České Budějovice), for his outstanding contribution to platyhelminthes systematics. The generic name is of feminine gender.

Remarks: Our observations show some important characteristics justifying the erection of the new genus *Scholzia* for *Tetrabothrium emarginatum*. *Scholzia* differs from all the other genera of the Proteocephalinae (*Proteocephalus* Weinland, 1858; *Crepidobothrium* Monticelli, 1900; *Ophiotaenia* La Rue, 1911; *Deblocktaenia* Odening, 1963; *Macrobothriotaenia* Freze, 1965; *Tejidotaenia* Freze, 1965; *Brayela* Rego, 1984; *Euzetiella* de Chambrier, Rego & Vaucher, 1999; *Thaumasioscolex* Cañeda-Guzmán, de Chambrier & Scholz, 2001; *Pseudocrepidobothrium* Rego & Ivanov, 2001 and *Glanitaenia* de Chambrier, Zehnder, Vaucher & Mariaux, 2004) by the following combination of features: (1) the morphology of the scolex, i.e. cup-shaped suckers, apical region very wrinkled (compare de Chambrier & Vaucher, 1999 and Rego, 1999 for Neotropical proteocephalideans), (2) strobilar features such as the presence of four posterior lobes forming a velum, (3) the ovary and the vitellaria medullary with cortical projections into the velum, (4) a network of osmoregulatory canals within the apex region, and (5) the vitelline follicles posteriorly converging medially at the ovarian level.

Scholzia emarginata (Diesing) comb. nov. Figs 1-17, 27

Tetrabothrium emarginatum Diesing, 1850: 600; Diesing, 1856: Figs 1-8, plate 3; Braun, 1894-1900: 990 (plate XL, Fig. 8).
Nomimoscolex emarginatus (Diesing); Rego *et al.*, 1999: 334* (as *N. emarginatum*).
Myzophorus pirarara Woodland, 1935: 851, Figs 1-7; Brooks, 1995: 361.
Nomimoscolex pirarara (Woodland) Rego & Pavanelli, 1992: 288.
Proteocephalus pirarara (Woodland); de Chambrier & Vaucher, 1997: 225.

Type host: *Phractocephalus hemioliopterus* (Bloch & Schneider, 1801) (Siluriformes: Pimelodidae); vernacular name: "Pirarara".

Material studied: *Myzophorus pirarara* Woodland, 1935 - syntypes BMNH 1965.2.23.146-153 (Amaz 58, Amaz 123). Recently collected material: Itacoatiara, Amazon River, Brazil, INVE 18320, 18321, 18322, 16.09.1992; INVE 21997, 21998, 09.10.1995; INVE 22050, 18.09.1995; INVE 21888 05.10.1995.

Site of infection: First quarter of intestine.

Type locality: *Tetrabothrium emarginatum*: "Mato Grosso", Brazil, 13 June 1828, collected by Natterer. *Myzophorus pirarara* Woodland, 1935: Manaus and Gurupa, Amazon river, Brazil, autumn 1931.

Distribution: Amazon River Basin, Brazil.

Redescription

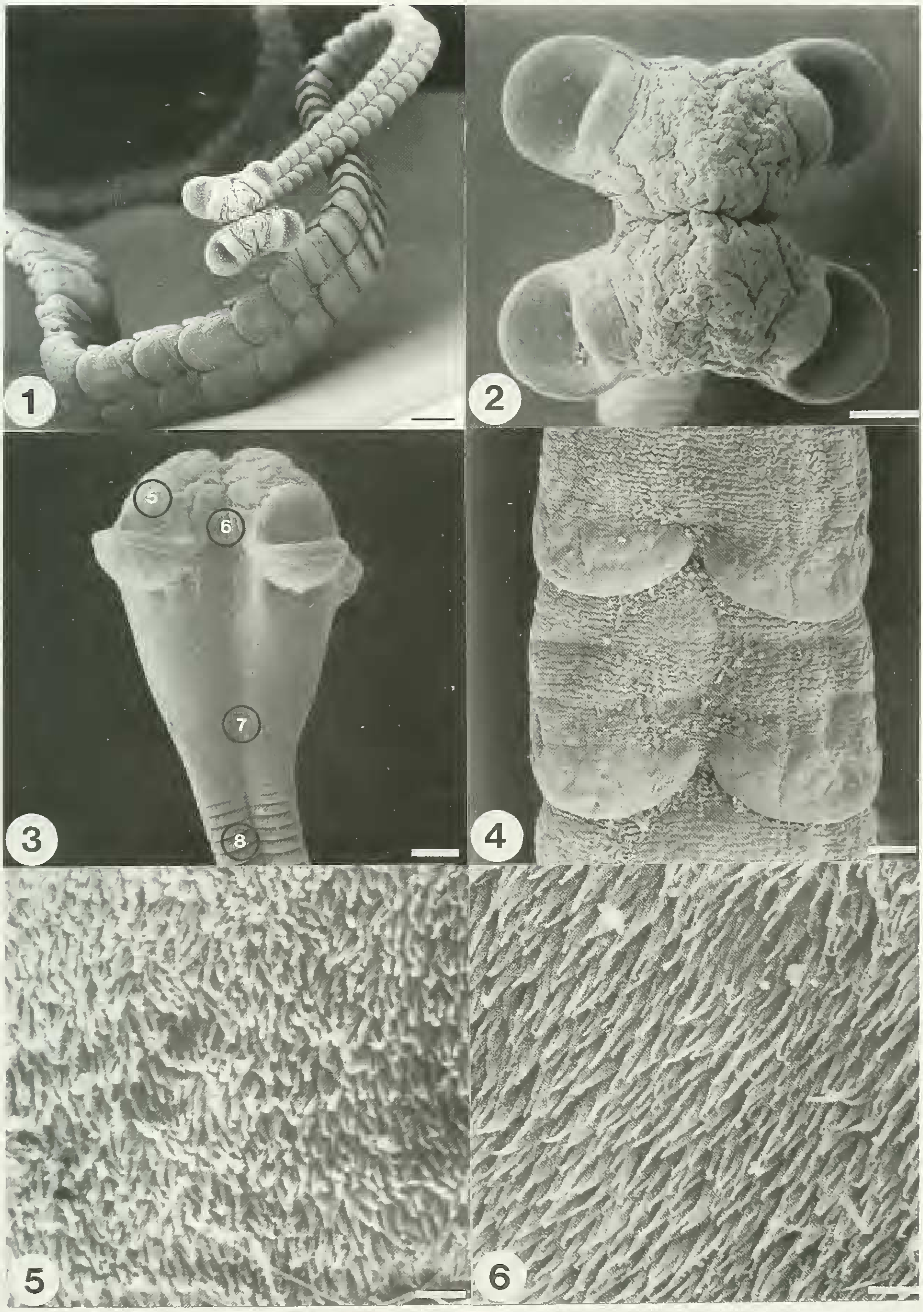
Proteocephalidea, Proteocephalidae. Strobila craspedote with four-lobed velum (Figs 1, 4, 13-14), 20-42 mm long (33 mm long according to Woodland's description). 61-69 immature proglottides (up to appearance of spermatozoa in vas deferens), 4-9 mature proglottides (up to appearance of eggs in uterus), 4-15 pregravid proglottides (up to appearance of hooks in oncospheres), 5-16 gravid proglottides, 68-114 proglottides in total number.

Scolex wider than neck, 485-720 (TM = 585-820) wide (Fig. 3). Apical region wrinkled, without apical organ (Fig. 2). Concentration of glandular cells posterior to apex. Scolex sometimes inflated due to inflation of ventral osmoregulatory canals. Suckers uniloculate, oval, directed anteriorly, 200-290 (TM = 175-240) in diameter (Figs 2, 3). Longitudinal musculature poorly developed, with indistinct bundles of isolated fibres, with few anastomoses, more dense laterally (Figs 15, 17).

Testes medullary, 69-93 (TM = 51-80) in number, in one field, not overlapping cirrus sac and vas deferens, reaching laterally to vitelline follicles, almost reaching to posterior margin, overlapping ovary ventrally (Figs 13-14). Testes spherical to oval, 55-95 (TM = 65-110) in diameter. Genital pores irregularly alternating, PP = 23-37% (n = 20; TM = 24-34%, n = 13) from anterior margin of mature proglottis (Figs 13-14). Genital atrium present.

Cirrus sac elongated, thin-walled, 225-365 (TM = 295-375) long and 105-160 wide, PC = 31-43% (CV = 8%, n = 21; TM = 35-42%, n = 12). Cirrus evaginated (TM = 300-800 long), with inflated proximal part and elongated distal part, without visible

* Rego *et al.* (1999, p. 334) for the host *Luciopimelodus pati*, reversed *Nomimoscolex emarginatus* (Diesing, 1850) and *Nomimoscolex piracatinga* Woodland, 1935 (= *Monticellia amazonica* de Chambrier & Vaucher, 1997). The cited cestode species for *Luciopimelodus pati* in Rego *et al.* (1999, p. 334) has to be *N. piracatinga* and not *N. emarginatus*, which is a parasite of *Phractocephalus hemioliopterus*. The redescription (Rego *et al.*, 1999, p. 334) and the legends of figures 45-47 (p. 318) for *Nomimoscolex piracatinga* confirm our observation.



FIGS 1-6. *Scholzia emarginata* (Diesing, 1850), INVE 18321. 1. Entire worm, general view. 2-3. Scolex. 2. Apical view. 3. Dorso-ventral view. 4. Details of proglottides velum. 5-6. Blade-like spiniform microtriches. 5. Marginal ring surface of suckers. 6. Surface between suckers. Scale-bars: 1 = 200 μm; 2-4 = 100 μm; 5-6 = 2 μm.

microtriches (Fig. 27). Cirrus invaginated, 215-315 long, occupying up to 80% of cirrus sac length. Vas deferens forming several loops situated in field between proximal part of cirrus sac and middle part of uterus, crossing it. Vagina anterior (54%; TM = 56%) or posterior (46%; TM = 44%) to cirrus sac, with thick terminal part and small muscular sphincter (Figs 13-14).

Ovary dorso-medullary situated, bilobed, folliculate, with numerous dorsal follicles, crossing posteriorly longitudinal muscles into dorsal cortex, reaching velum (Fig. 17). OV = 63-72% (n = 21, CV = 4%; TM = 67-72%, n = 7). Vitellaria medullary, formed by small follicles in two lateral bands, situated ventrally (Figs 14, 17). Vitelline follicles confluent at level of ovary, with some follicles crossing longitudinal musculature, penetrating ventral cortex in velum (Fig. 17). Uterus medullary, with development of type 1 (see de Chambrier *et al.*, 2004b). Formation of uterus: in immature proglottides, uterine stem straight, formed by thick layer of chromophil cells, with lumen in first mature proglottides (Fig. 13). Appearance of uterine thick-walled diverticles with lumen in first pregravid proglottides. Uterine aperture often precociously formed, of *Crepidobothrium* type (see de Chambrier, 1989) (Fig. 14). Uterus with 8-15 (TM = 12-21) diverticles on each side of proglottides.

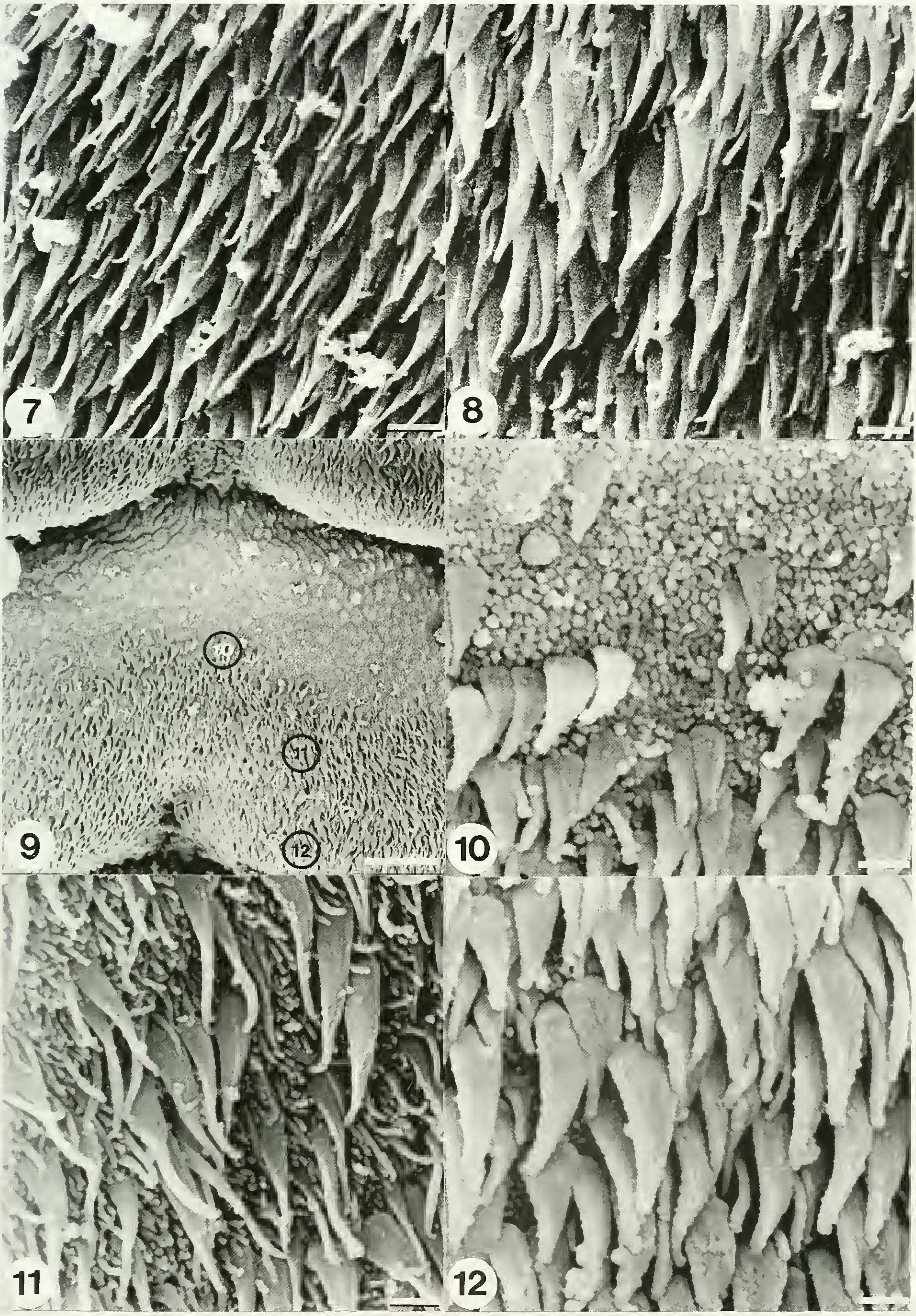
Eggs spherical, with hyaline collapsed outer envelope about 55 in diameter; embryophore round, consisting of two layers; outer layer 18-20 in diameter, larger than nuclei-containing envelope; oncospheres spherical, 9-11 in diameter with 6 hooklets 4.5-5 long (Fig. 16).

Ventral osmoregulatory canals without observable anastomoses, situated between testes and vitellaria, often overlapping testes field (Figs 13-14). Dorsal osmoregulatory canal often overlapping vitelline follicles.

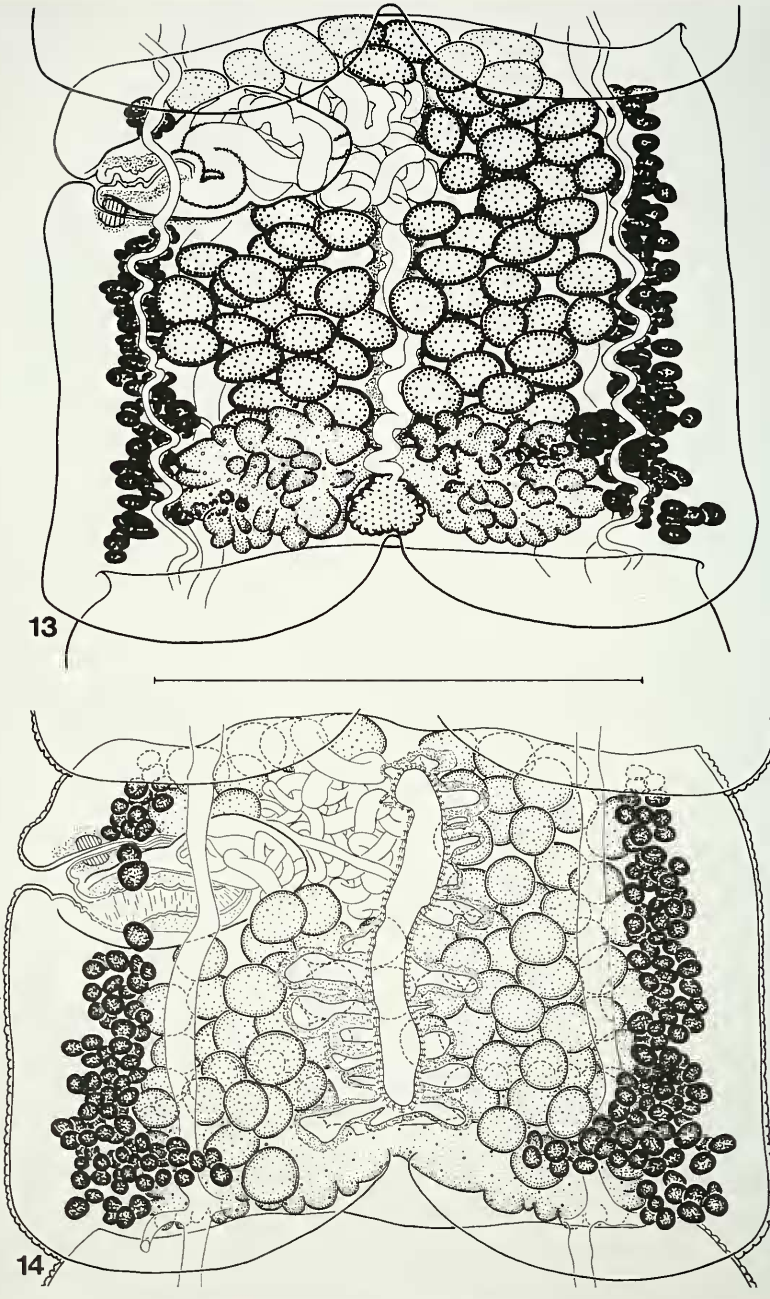
Distribution of microtriches: Anterior part covered with BLS progressively longer from marginal ring surface of suckers, 1.12-1.32 (x = 1.23, n = 6), 0.24-0.40 (0.32) wide at base, D = 2.45-2.66 (x = 2.51, n = 6) (Fig. 5), to intersuckers, 2.52-2.88 (x = 2.65, n = 6) long, 0.48-0.56 (0.52) wide at base, D = 1.25-2 (x = 1.67, n = 6) (Fig. 6), to proliferation zone (neck) 3.32-5.12 (x = 3.95, n = 9) long, 0.80-1.20 (1.05) wide at base, D = 0.50-0.75 (x = 0.63, n = 6) (Fig. 7), to immature proglottis surface 4.82-5.82 (x = 5.29, n = 6) long, 1.35-1.65 (1.45) wide at base, D = 0.25-0.50 (x = 0.38, n = 6) (Fig. 8). Mature proglottis surface covered with 3 types of microtriches (Fig. 9). Anterior: cushion like papilliform microtriches. Middle: cushion like papilliform microtriches 0.12-0.18 (x = 0.16, n = 8) in diameter, interspersed with BLS 1.90-2.60 (x = 2.14, n = 8) long and 0.72-1.12 (0.93) wide at base (Fig. 10). No density value is given due to it is a transitional surface. Posterior surface (velum) with BLS 2.90-4.04 (x = 3.57, n = 6) long and 0.62-0.80 (0.72) wide at base, interspersed with filiform microtriches 0.44-0.52 (x = 0.48, n = 6) long and 0.08-0.14 (0.11) wide, D = 0.25-0.44 (x = 0.35, n = 5 spiniform / 5.58-7.25 (6.52) filiform (Fig. 11). Marginal surface of mature proglottis (velum) with spiniform microtriches 2.84-3.76 (x = 3.28, n = 7) long, 0.98-1.20 (1.14) wide at base, D = 0.38-0.63 (x = 0.49, n = 4) (Fig. 12).

Remarks

Scholzia emarginata (Diesing, 1850) belongs to the Proteocephalinae as defined by Schmidt (1986) and Rego (1994) because of the medullary position of the testes, ovary, vitelline follicles, and uterus.

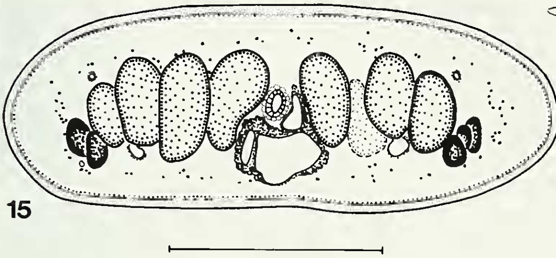


FIGS 7-12. *Scholzia emarginata* (Diesing, 1850), INVE 18321. 7-8. Blade-like spiniform microtriches. 7. Proliferation zone surface. 8. Immature proglottis surface. 9-12. Mature proglottis. 9. Three types of microtriches: 10. Cushion-like papilliform, 11. Blade-like spiniform and filiform. 12. Blade-like spiniform. Scale-bars: 7-8 = 2 μm; 9 = 10 μm; 10-12 = 1 μm.



FIGS 13-14

Scholzia emarginata (Diesing, 1850). 13. INVE 18322, dorsal view of a mature proglottis. 14. INVE 21997, ventral view of a pregravid proglottis. Scale-bars = 500 μm.



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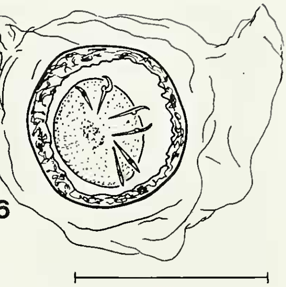

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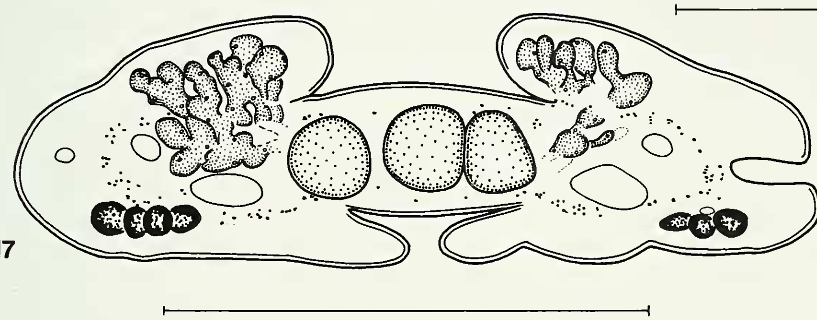

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Figs 15-17

Scholzia emarginata (Diesing, 1850). 15. Syntype of *Myzophorus pirarara*, BMNH 1965.2.23.146-153, cross section at level of the middle of a proglottis showing the medullary disposition of genital organs related to the internal longitudinal musculature. 16. INVE 18321, egg drawn in distilled water. 17. INVE 18320, Cross section at level of the velum, showing the cortical disposition of the vitellaria related to the internal longitudinal musculature and the penetration of the ovary from the medulla to the cortex. Scale-bars: 15 = 250 μm; 16 = 20 μm; 17 = 500 μm.

The presence of velum is uncommon within Proteocephalidea. To our knowledge, only *Zygobothrium megacephalum* Diesing, 1850 possesses similar velum in the posterior margin of proglottides (see Woodland, 1933, Figs 8-10, pl. 11). Furthermore, both species possess some vitelline follicles within the velum and these characteristics may represent an interesting convergence especially because both parasites are harboured by the same host species, *Phractocephalus hemioliopterus*.

The surface of *S. emarginata* is covered with 3 types of microtriches: cushion-like papilliform, filiform, and blade-like spiniform. The smallest spiniform microtriches are covering the surface of the marginal ring of suckers and the largest are covering the surface of the immature proglottis. The mature proglottis surface presents the highest diversity of microtriches. The posterior surface of mature proglottis (velum) is covered with longer and more slender spiniform microtriches than those covering the margin of the velum. The papilliform microtriches covering the anterior surface of mature proglottides become longer in the posterior surface (velum), and probably they are hidden by the spiniform microtriches covering the marginal region of the velum. The highest density of BLS is covering the marginal ring of suckers (2.45-2.66). On the other hand, the density is also high in the posterior surface of mature proglottis (0.35 BLS / 6.52 filiform). Contrary to the opinion of de Chambrier & Vaucher (1997, p. 225), the cirrus does not bear neither spines nor spiniform microtriches (see Fig. 27).

We must note that in the English translation of Freze (1965), there is an inversion of figures. The figure 245 (supposed to be *Myzophorus pirarara*) corresponds in fact to *Nomimoscolex piraeeba* Woodland, 1934. The figure 143 represents *Myzophorus pirarara*.

We illustrated (Fig. 15) the same cross section (type material BNHM 1965.2.23.146-153, Amaz. 123 A3) figured by Woodland (1935, Fig. 5, pl. 2). The subtegumental layer of longitudinal muscle-fibres is in fact less developed in the type material than shown in Woodland's figure.

Proteocephalus hemioliopteri de Chambrier & Vaucher Figs 18-26, 28-32

Myzophorus woodlandi Rego, 1984: 259, Fig. 6, preoccupied by *Proteocephalus woodlandi* Moghe, 1926.
Nomimoscolex woodlandi (Rego) Rego & Pavanelli, 1992: 288; Rego & al., 1999: 337.
Proteocephalus hemioliopteri de Chambrier & Vaucher, 1997: 225 (replacement name).

Type host: *Phractocephalus hemioliopterus*.
Materiel studied: *Myzophorus woodlandi* Rego, 1984 syntype, IOC 32.088 a-g. Recently collected material: Itacoatiara, Amazon River, Brazil, INVE 18123, 17.09.1992; INVE 18324, 16.09.1992; 19307, 18.09.1992; 22015, 15.09.1992; 22048, 18.10.1995.
Site of infection: Anterior quarter of intestine.
Type locality: Manaus and Gurupa, Amazon river, Brazil, autumn 1931.
Distribution: Amazon River.

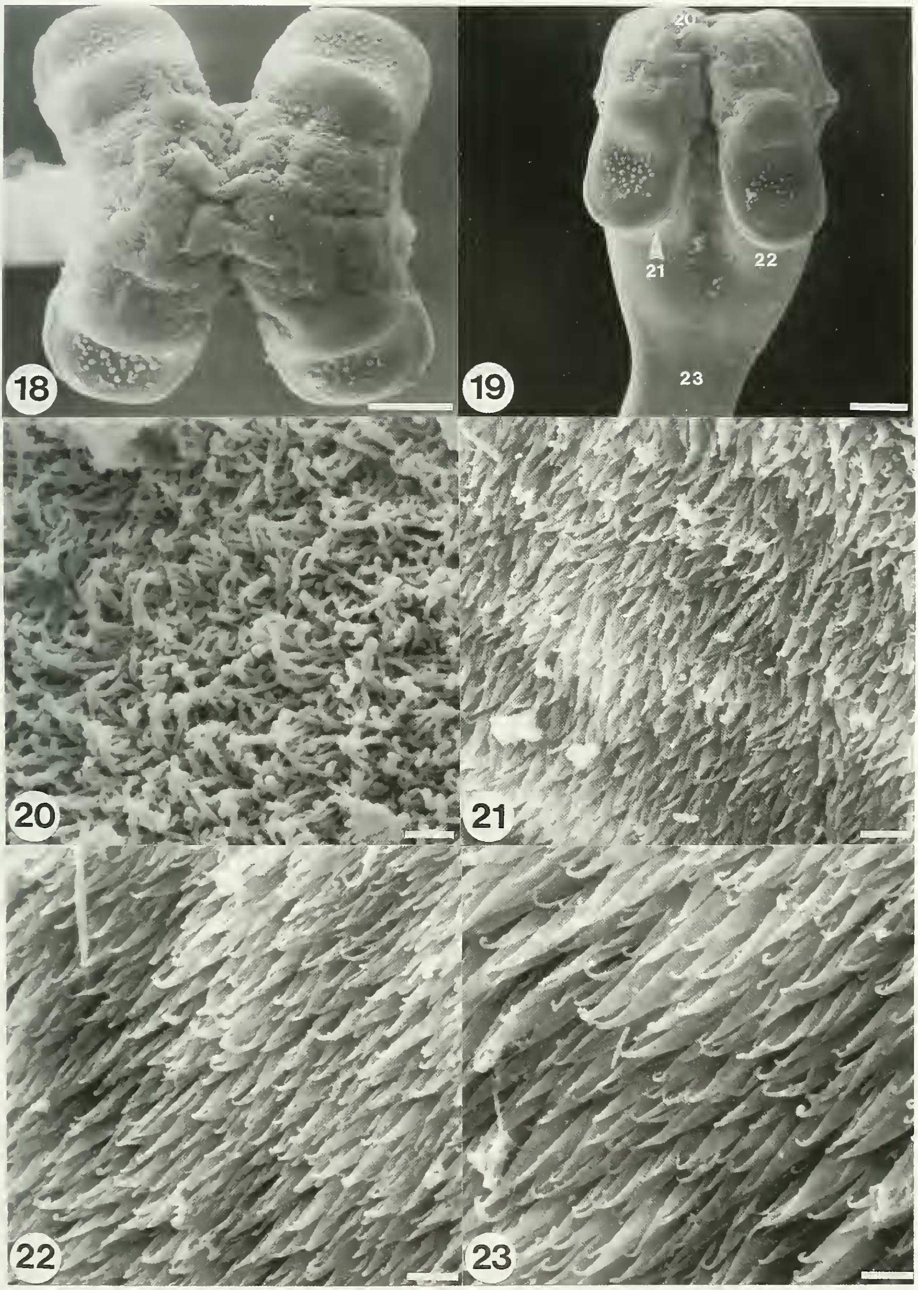
REDESCRIPTION

Proteocephalidea, Proteocephalidae. Strobila acraspedote, 10-17 mm long, consisting of 18-31 immature proglottides, 1-2 mature proglottides,1-3 pregravid proglottides; 28-39 proglottides in total number.

Scolex larger than neck, lobate, without apical organ, measuring 400-525 (TM = 500-590) (Figs 18-19). Scolex sometimes inflated by ventral osmoregulatory canals. Apical region wrinkled (Fig. 18). Under apex, osmoregulatory system forming densely reticulated plexus. Suckers uniloculate, oval, directed laterally or anteriorly, 180-260 (TM = 220-280) in diameter (Fig. 18). Internal longitudinal musculature weakly developed (Figs 29-30), formed by bundles of anastomosing fibres clearly seen in immature proglottides.

A total of 57-92 (x = 75, n = 10, TM = 67-77) testes medullary, in one field, formed by one or two irregular layers, not overlapping cirrus sac and vas deferens, reaching laterally vitellaria (Fig. 28). Testes spherical to oval, 65-100 (TM = 45-85) in diameter (Fig. 28). Genital pores alternating irregularly, PP = 36-45% (n = 17, TM = 34-38%). Genital atrium present.

Cirrus sac elongated, thin-walled, 145-305 (TM = 150-260) long and 90-130 wide, PC = 36-48% (n = 12, TM = 30-35%) (Fig. 28). Evaginated cirrus up to 765 long. Invaginated cirrus, 110-225 long, occupying more than 80% of cirrus sac length. Vas deferens very long and sinuous, expanded anteriorly to cirrus sac, situated between proximal part of cirrus sac and middle part of uterus, crossing it (Fig. 28).



FIGS 18-23. *Proteocephalus hemioliopteri* de Chambrier & Vaucher, 1997. 18-20. INVE 18323. 18. Scolex, apical view. 19. Scolex, dorso-ventral view. 20. Filiform microtriches, apical surface of scolex. 21-23. INVE 19307, blade-like spiniform microtriches. 21. Non-adherent surface of suckers. 22. Surface posterior to suckers. 23. Proliferation zone. Scale-bars: 18-19 = 100 μm; 20 = 1 μm; 21-23 = 2 μm.

Vagina anterior (57%) or posterior (43%) (TM = in front or behind) to cirrus sac, with thick terminal part encircling small distal annular muscular sphincter measuring 70 in diameter. Vaginal canal looped just before reaching the seminal receptacle.

Ovary medullary, bilobate, butterfly-shaped, laterally folliculate. OV = 62-71% (TM = 54-65%) (Figs 28, 31).

Vitellaria medullary formed by small follicles measuring 25-60 in diameter, disposed in two lateral bands, occupying nearly all proglottis length, interrupted at level of cirrus sac (Fig. 29-30). Uterus medullary, with development of type 1 (see de Chambrier *et al.*, 2004b). Formation of uterus: in immature proglottides, uterus medullary preformed, as an elongated concentration of chromophil cells and occupying the entire length of proglottis, formed by a tick layer of chromophil cells (Fig. 28). Lumen present in uterine stem in first mature proglottis. Appearance of uterine diverticles with lumen in the first pregravid proglottides. Appearance of uterine aperture of *Crepidobothrium* type (see de Chambrier, 1989). Eggs usually laid before apparition of hooklets in oncosphere. Uterus with simple diverticles 12-19 on each side. When full of eggs, lateral diverticles occupying up to 60 % of pregravid proglottis width. Discharging of immature eggs by a precocious uterine aperture (Fig. 31).

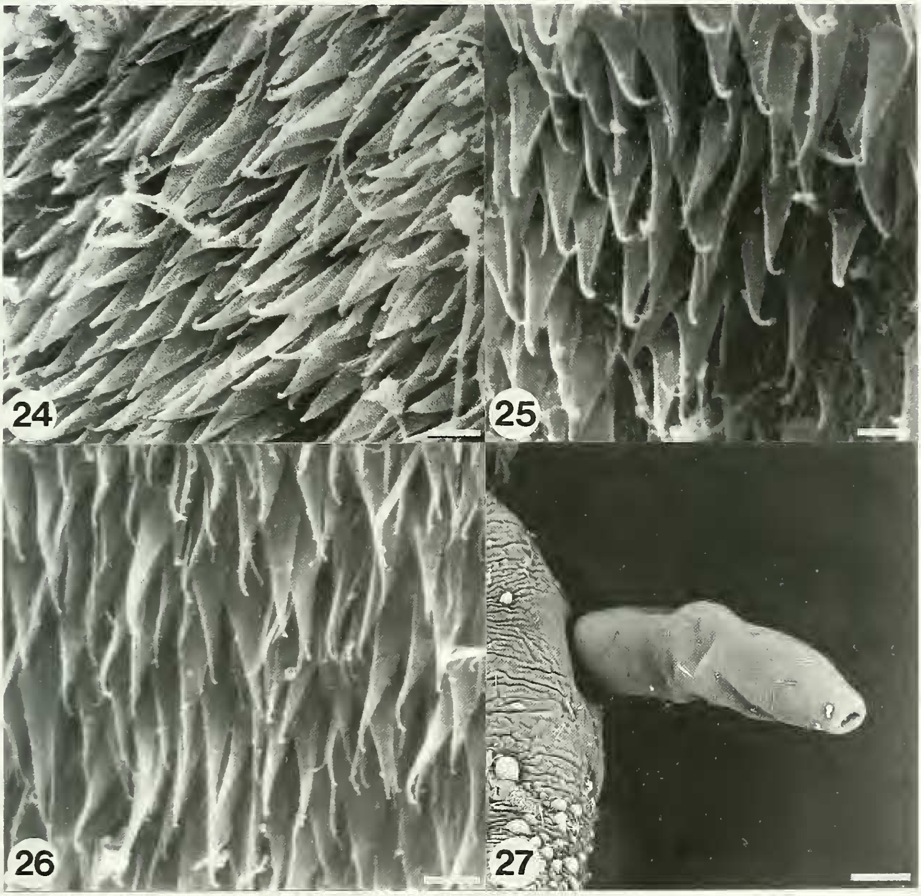
Eggs spherical, with hyaline outer envelope (collapsed in our material); embryophore round, consisting of two layers; outer layer 14-20 in diameter, larger than nuclei-containing envelope; oncospheres oval, 9-10 x 12-13 with 6 hooklets about 5 long (Fig. 32).

Ventral and dorsal osmoregulatory canals situated between testes and vitellaria. Dorsal canals often overlapping dorsally vitelline follicles (Figs 28-30). Lateral short canal emerging from ventral canal and ending ventrally beneath tegument.

Distribution of microtriches: Apical surface of scolex covered with filiform microtriches 1.24-1.73 (x = 1.46, n = 5) long, 0.06-0.12 (0.09) wide, D = 2.00-3.50 (x = 2.50, n = 5) (Fig. 20). Non-adherent surface of suckers covered with BLS 1.84-2.02 (x = 1.92, n = 6) long, 0.56-0.80 (0.65) wide at base, D = 1.25-2.75 (x = 1.70, n = 6) (Fig. 21). Surface below suckers covered with BLS 2.45-3.30 (x = 2.90, n = 6) long, 0.80-0.90 (0.83) wide at base, D = 0.75-1.50 (x = 1.08, n = 6) (Fig. 22). Proliferation zone (neck) surface covered with long BLS 4.70-5.85 (x = 5.01, n = 6) long, 1.20-1.30 (1.26) wide at base, D = 0.50-1.00 (x = 0.70, n = 6) (Fig. 23). Immature proglottis surface covered with longer BLS 4.41-5.53 (x = 4.88, n = 6) long, 1.18-1.65 (1.36) wide at base, D = 0.25-0.75 (0.50, n = 6) (Fig. 24). Anterior surface of mature proglottis covered with large BLS 5.16-5.96 (x = 5.59, n = 7) long, 1.28-1.80 (1.54) wide at base, D = 0.11-0.19 (x = 0.17, n = 6); interspersed with small BLS. They only are observed when large spiniform microtriches are lost (Fig. 25). Posterior surface of mature proglottis covered with giant BLS 6.82-8.35 (x = 7.27, n = 7) long, 1.29-1.88 (1.59) wide at base, D = 0.30-0.44 (x = 0.34, n = 6) (Fig. 26).

Remarks

Rego (1984, Fig. 6 a-e) figured *Myzophorus woodlandi* with the collection number IOC 32088 a-g. We examined the type material and observed that Fig. 6d corresponds to *Pseudocrepidobothrium* sp. (nec *P. eirasi* (Rego & de Chambrier,



Figs 24-27

24-26. *Proteocephalus hemioliopteri* de Chambrier & Vaucher, 1997, INVE 19307, blade-like spiniform microtriches. 24. Immature proglottis surface. 25. Anterior surface of a mature proglottis. 26. Posterior surface of a mature proglottis. 27. *Scholzia emarginata* (Diesing, 1850). INVE 18321, evaginated cirrus. Scale-bars: 24-26 = 2 μm; 27 = 50 μm.

1995)) and not to *Myzophorus woodlandi* (= *Proteocephalus hemioliopteri*). The figures 6b and 6c correspond respectively to the IOC number 32088d and 32088b (not formally designed as type material), but the Fig. 6e is of number IOC 32089 which corresponds to *Proteocephalus piramutab* (Woodland, 1933) Rego, 1984.

The tegument surface of *P. hemioliopteri* is covered with 2 types of microtriches: filiform and spiniform. The surface of the apex of the scolex is covered with long filiform microtriches (1.46 x 0.09). The size of spiniform microtriches increases in antero-posterior direction. The smallest spiniform microtriches are covering the non-adherent surface of the suckers (1.92 x 0.65) and the largest are covering the posterior region of the mature proglottis (7.27 x 1.59). The surface of the apex of the scolex, cov-

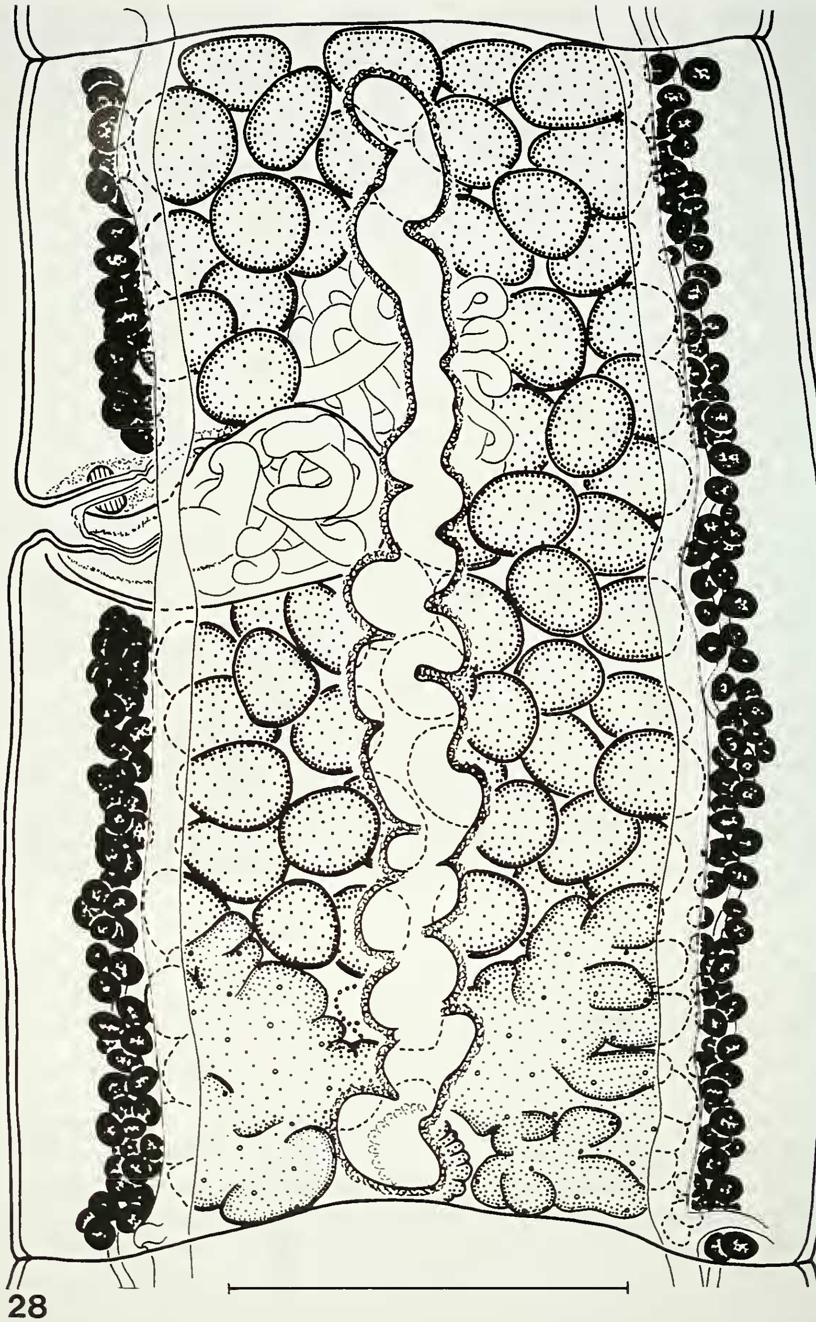


FIG. 28

Proteocephalus hemioliopteri de Chambrier & Vaucher, 1997. INVE 18323, ventral view of a pregravid proglottis. Scale-bar: 250 μm.

29

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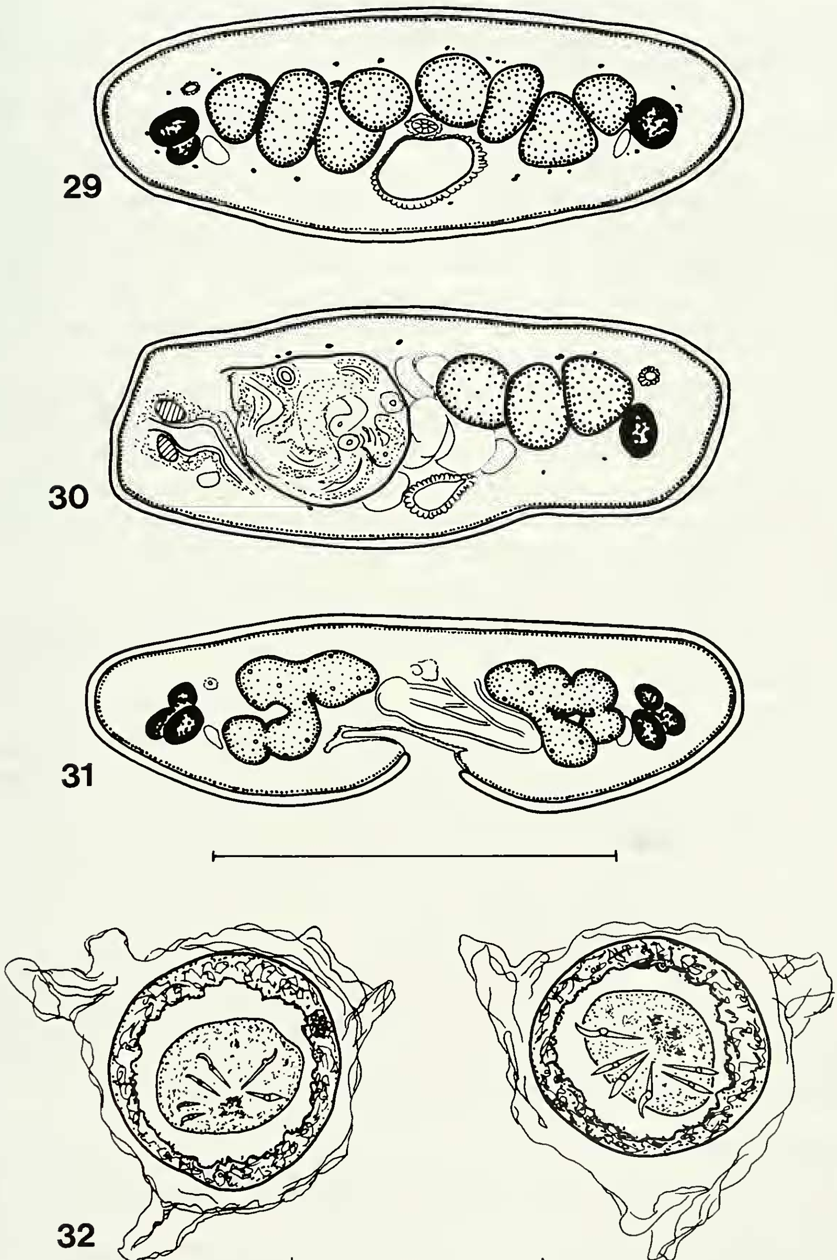
31



32

FIGS 29-32

Proteocephalus hemioliopteri de Chambrier & Vaucher, 1997. 29-31. INVE 18323, cross sections. 29. At level of the middle of a proglottis. 30. At level of cirrus pouch. 31. At level of the ovary. 32. INVE 18323, egg drawn in distilled water. Scale-bars: 29-31 = 250 μm; 32 = 20 μm.

ered with filiform microtriches, has the highest density (2.00-3.50) while the surfaces with BLS have lower densities. Among the surfaces with BLS, the non adherent surface of suckers has the higher density (1.25-2.75).

DISCUSSION

Although Thompson *et al.* (1980) made a careful ultrastructural study on microtriches of the Australian *Acanthotaenia tidswelli* Johnston, 1909, the morphology and distribution of the microtriches were not considered as an interesting character in the Proteocephalidea until recently. Only the scoleces of 1 species of *Electrotaenia* Nybelin, 1942, 1 species of *Monticellia* La Rue, 1911, and 2 species of *Nomimoscolex* Woodland, 1934 were analysed (de Chambrier *et al.*, 2004c; Gil de Pertierra, 2002, 2004).

Three types of microtriches were observed in *S. emarginata* and 2 types of microtriches in *P. hemioliopteri*. We found notably distinct pattern of microtriches distribution in mature proglottis of both species (compare Figs 9-12 and 22-23). In *S. emarginata*, only the marginal surface (velum) of proglottis is covered with giant BLS. The anterior surface bears cushion like papilliform while the posterior surface is covered with BLS interspersed with filiform microtriches. In contrast, all the surface of mature proglottis in *P. hemioliopteri* is covered with BLS.

Our studies shows that the distribution pattern was not useful to discriminate genera but suggests that this character may be useful as supplementary character to distinguish species.

Despite a high similarity between *Proteocephalus hemioliopteri* and *Scholzia emarginata* in the scolex morphology, the external and internal body morphology is quite distinct. Both species are situated together in the same intestine localisation, in the first quarter of the gut. As the scolex is the structure having the most intimate interaction with the intestine surface, it is reasonable to consider that this very plastic structure may have the highest selection pressure. Lundberg *et al.* (1988) found a fossil catfish from the upper Miocene they identified as *Phractocephalus hemioliopterus*. This fossil provides an example of a long and conservative evolutionary history for a freshwater catfish. If we speculate on a very ancient association between this host and both proteocephalideans species, we may hypothesise that their scoleces have evolved to reach a close morphological similarity and that their present shape is thus a result of convergence. The basal position of *Proteocephalus hemioliopteri* in the molecular tree of de Chambrier *et al.* (2004b, Fig. 1) corroborates this hypothesis.

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